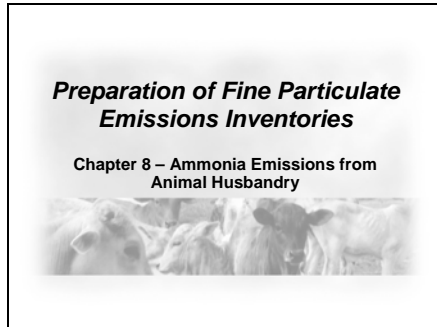


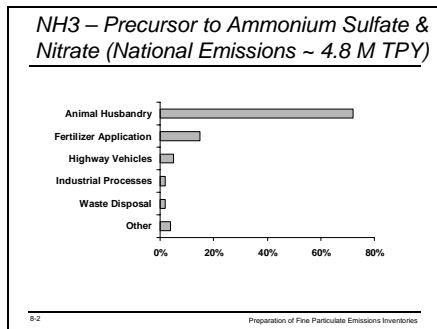
Chapter 8 – Ammonia Emissions from Animal Husbandry

8 - 1



This lesson presents the issues associated with estimating ammonia emissions from animal husbandry operations and some of the efforts that are being undertaken to address these issues.

8 - 2



Almost 5 million tons a year of ammonia are emitted nationally. As the graph demonstrates, animal husbandry is the source of the majority of ammonia emissions nationally.

8 - 3

Update to Ammonia from Animal Husbandry is Timely

- **Inverse modeling** suggests overestimation of ammonia.
- Shortcomings of old NEI
 - Probable errors in emission factor selections, especially for beef.
 - Does not use information on variability of emissions due to different manure handling practices within a given animal industry.
 - Does not make total use of information of available National Agricultural Statistics Service (NASS) data on different animal populations, by average live weight.

8-3

Preparation of Fine Particulate Emissions Inventories

It is important to address ammonia emissions from animal husbandry because inverse modeling suggests that ammonia emissions may be overestimated.

Inverse modeling:

- involves doing a complete chemical transformation and transport modeling of an area
- requires accounting for all of the ammonia through transformation and deposition processes.
- results indicate that ammonia may be overestimated nationally when compared to ammonia in the ambient air

Some problems associated with the old NEI:

- probable errors in the emission factor selections, especially for beef.
- does not use information on variability of emissions due to different manure handling practices within a given animal industry
- does not make total use of the National Agricultural Statistic Service data on different animal populations by weight
- does not take temperature into account, which would greatly increase the temporal variation in ammonia emissions.

8 - 4

Update to Ammonia from Animal Husbandry is Timely (Cont'd)

- **Effluent Guidelines** project provided information on production & waste handling practices (new).
- **National Academy of Science (NAS)** committee recommended a long data gathering effort.
 - **Old NEI estimates** are not the best we can do in the interim (while this data gathering is undertaken).

8-4 Preparation of Fine Particulate Emissions Inventories

In addition, EPA's water emission effluent guidelines project has provided some new information on animal production and waste handling practices.

Also, the National Academy of Sciences, at the behest of the agricultural community, has reviewed EPA's inventory work, and recommended a long-term data-gathering effort.

8 - 5

Improved Basis for Interim NEI Update

- Provides improved data on populations, practices, and emissions.
- Allows a switchover to a process-based framework that is common, transparent and that allows partial updating as more data becomes available.
- Motivates and provide structure for relevant data collection.
- Opportunity to educate users about data limitations, proper use.
- Goal: Higher animal production States will begin to adopt / offer improvements to new method.

8-5 Preparation of Fine Particulate Emissions Inventories

A recent EPA report provides a basis for making interim improvements to the NEI through improved data on populations, practices, and emissions.

It is the beginning of a switch-over to a process-based framework that is a consistent and transparent way of estimating emissions.

Advantages:

- will allow for partial updating as better data become available
- provides motivation and a structure for making data-collection improvements
- provides an opportunity to educate users about data limitations and the proper use of the data.

The goal is for the higher animal production states to begin to adopt and offer improvements to the NEI using this new method.

8 - 6

Overview of New Estimation Methodology

- Step 1: Estimate average annual animal populations by animal group, state, and county.
- Step 2: Identify Manure Management Trains (MMT) used by each animal group and then estimate the distribution of the animal population using each MMT.
- Step 3: Estimate the amount of nitrogen excreted from the animals using each type of MMT, using general manure characteristics.

8-6 Preparation of Fine Particulate Emissions Inventories

Let's review the six steps that comprise this new methodology for estimating ammonia emissions from animal husbandry operations.

8 - 7

Overview of New Estimation Methodology (Cont'd)

- Step 4: Identify or develop emission factors for each component of each MMT.
- Step 5: Estimate ammonia emissions from each animal group by MMT and county for 2002.
- Step 6: Estimate future ammonia emissions for years 2010, 2015, 2020, and 2030.

8-7 Preparation of Fine Particulate Emissions Inventories

8 - 8

Step 1: Population Estimates

- Animals: Dairy, beef, swine, and poultry.
 - Keep weight groups & animal types distinct.
- State-level population: 2002 NASS.
- County apportionment: using 1997 Census of Agriculture.
 - Privacy Issue - Where state and/or county is not disclosed, divide equally.

8-8 Preparation of Fine Particulate Emissions Inventories

The first step in this process is estimating average animal populations by animal group, state, and county.

This step uses 2002 NASS data for state-level populations, and the 1997 census of agricultural to apportion the state-level NASS data to the county level. However, there are some privacy issues with regard to animal populations.

For example, a county with only one large facility would create an industrial privacy issue since that facility will not want their competition to know how many animals they are raising.

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Step 2: Manure Management Trains

- 15 MMT's plus permutations (similar to "model farms" used in past approaches).
 - e.g., Housing, waste storage, land application type.
- Non-feedlot outdoor confinement (e.g. pasture) is one of the trains for swine, dairy, and beef.
- MMT's represent different pathways for escape of ammonia to the air.
- MMT "mix" varies by state, not within a State.
 - Another "opportunity" for improvement

8-9 Preparation of Fine Particulate Emissions Inventories

The second step is using Manure Management Trains (MMTs) for each animal group to estimate the distribution of the animal population.

Fifteen MMTs have been identified. Some of the variables that affect the different trains include:

- the way animals are housed,
- waste storage methods, and
- the land application methods that are used.

For example, the non-feedlot outdoor confinement is one of the trains for swine, dairy, and beef. The MMTs represent different pathways for the escape of ammonia into the air.

In applying the MMT approach to estimate the 2002 ammonia inventory, the mix of MMTs is assumed to vary by state, but not within a state.

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Step 2: Manure Management Trains (Cont'd)

- Animal population, etc. is allocated among the applicable trains.
- Note: Final stage in each train is land application.

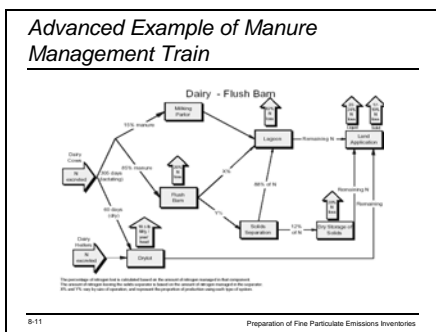
8-10 Preparation of Fine Particulate Emissions Inventories

Animal population is allocated among the applicable trains.

For example, in a given state 20% of the hogs may be handled using manure management train 3, another 60% may be using manure management train 7, and the rest of them may be using manure management train 14.

Finally, it should be noted that the final stage on every train is land application.

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This graphic illustrates an advanced MMT, one of several such trains for the dairy industry.

This MMT begins with the amount of nitrogen excreted by dairy cows.

The train traces the manure through the different handling options and shows how much is handled in different ways. The train also shows the nitrogen and ammonia emissions at the various handling points.

For example, there is nitrogen loss in the flush barn and the lagoon, and ammonia loss in the dry lot. There are other trains that provide similar information for other farm industries. These trains characterize a type of industry, and the general way that manure would be handled in a facility.

8 - 12

Step 3: Nitrogen Excreted

- Typical animal weights (within a type and weight range)
- Nitrogen per 1000 kg of live weight from NRCS *Agricultural Waste Management Field Handbook*
- Local agriculture experts could help improve this
 - Land Grant University Researchers / Extension Agents

8-12 Preparation of Fine Particulate Emissions Inventories

The third step involves using each type of MMT to estimate the amount of nitrogen excreted from the animals.

This step involves examining typical animal weights and data on the amount of nitrogen per thousand kilos of live weight. The data on the nitrogen amounts can be obtained from NRCS *Agricultural Waste Management Field Handbook*.

Another useful source of information is land grant university researchers and local agricultural extension agents. It is important to include experts in the agricultural industry in the inventory development efforts.

8 - 13

Step 4: Emission Factors

- Select the emission factor for each stage of each manure management train.
 - Some are lb/animal, some are percent air release of input ammonia.
 - Both kinds also determine ammonia transferred to next stage.
- Air emissions can never be higher than original manure content.
- Using stage-specific emission factors sets the stage for applying temporal profiles and process-related variability later.

8-13 Preparation of Fine Particulate Emissions Inventories

Step four involves identifying or developing the emission factors for each component of each MMT. Some of these factors are in pounds per animal, and some are percent air release of the input ammonia.

These factors are used to determine the amount of ammonia that goes to the next stage of the manure train process.

Under this approach, the air emissions could never be higher than the original manure content. Also, using this approach sets the stage for applying temporal profiles and process-related variables such as moisture and rainfall.

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Step 5: Apply for 2002

- Track ammonia release through each manure management train for each animal type, calculating air releases and transfers to next stage.
- Assumes no air emission controls at this time.
 - But can add control assumptions later, and see downstream consequences.
- Emissions are summed up to animal type and county
- Database is preserved with full detail for transparency and later revisions.

8-14 Preparation of Fine Particulate Emissions Inventories

The next step involves applying this methodology to estimate annual ammonia emissions from each animal group by MMT.

This includes:

- tracking the ammonia release through each MMT for each animal type and county, and
- calculating ammonia releases to the air and transfers to the next stage.

This whole process assumes no air emission controls at this time, but control assumptions could be added later. Emissions are summed up to animal type and county, but the database is preserved with full detail for transparency so that changes and improvements can be made.

8 - 15

Step 6: Future Years Projections

- 2010, 2013, 2020, and 2030.
- USDA and Food and Agricultural Policy Research Institute.
- Accounts for past observed cyclical populations.
- State-by-state population pattern.
 - Changes with time for dairy.
 - Fixed for others.

8-15 Preparation of Fine Particulate Emissions Inventories

The last step involves estimating ammonia emissions for future years.

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Comparison of 1999 and 2002 Ammonia NEIs

Animal Group	1999 NEI			2002 NEI		
	Population	Emission Factor lb/head/yr	Emissions Tons/year	Population	Emission Factor lb/head/yr	Emissions Tons/year
Cattle and Calves Composite	100,126,106	50.5	2,476,333	100,939,728	23.90	1,205,493
Hogs and Pigs Composite	63,095,955	20.3	640,100	59,978,850	14.32	429,468
Poultry and Chickens Composite	1,754,482,225	0.394	345,325	2,201,945,253	0.60	664,238
Total	1,917,704,286	N/A	3,461,758	2,362,863,831	N/A	2,299,199

8-16 Preparation of Fine Particulate Emissions Inventories

A comparison of the 1999 NEI version 3 with the 2002 NEI version 1 shows significant differences in the ammonia emissions.

As shown on this chart, about half of the emissions from all animals come from calves and cattle.

Also, total ammonia emissions from animal husbandry operations decreased significantly from 3.4 million in 1999 to 2.3 million in 2002.

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Ongoing Additional Improvements

- Plan to incorporate emission estimates for sheep, ducks, goats, and horses.
- Looking at more recent manure production and excretion rates by animal types and weight (may provide lower overall estimates than currently indicated in draft report).
- Looking into ways to better address spatial, seasonal, and regional differences in emissions.

8-17 Preparation of Fine Particulate Emissions Inventories

Other improvements that are being made to the NEI for animal husbandry operations:

- incorporating emission estimates for sheep, ducks, goats, and horses
- examining additional data sources to provide recently data on manure production and excretion rates by animal type and weight.
- examining ways to better address special, seasonal, and regional differences in emissions

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CMU Model and the NEI

- Carnegie Mellon University (CMU) has prepared a model for estimating ammonia emissions from agricultural activities, humans, wastewater treatment, wildfires, domestic and wild animals, transportation sources, industrial activities, and soils.
- Includes an improved methodology for fertilizer application when compared to the methodology used in previous versions of the NEI.
- EPA is evaluating the methodologies used for other source categories in the CMU model.

8-18

Preparation of Fine Particulate Emissions Inventories

Carnegie Mellon University has prepared a model for estimating ammonia emissions from agricultural activities, humans, wastewater treatment, wildfires, domestic and wild animals, transportation sources, industrial activities, and soils.

The Carnegie Mellon model includes an improved methodology for fertilizer application when compared to the methodology used in previous versions of the NEI.

EPA is evaluating the methodologies used for other source categories in the Carnegie Mellon model.

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